UNIVERSITY OF IOWA STUDIES

STUDIES IN EDUCATION

A METHOD FOR DETERMINING THE HOUSING REQUIREMENTS OF JUNIOR HIGH SCHOOL PROGRAMS

by

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CHAPTER I

INTRODUCTION

PHYSICAL FEATURES OF BUILDINGS

The problems dealing with the more important physical features of junior high school buildings have been quite satisfactorily solved. The standards of size of rooms, width of corridors, height of ceilings, location of stairs, lighting, toilets, drinking fountains, rest rooms, cafeterias, and auditoriums are quite well known. The expansibility of school buildings as they are built today permits the erection of additions to take care of large increases in school population. Future changes in curricula and in methods of teaching which may require radical changes in the buildings are adequately provided for in the flexibility of the interior arrangements of the buildings built today. It seems, therefore, that problems such as these have been fairly well solved, and since they are general in nature do not apply peculiarly to the junior high school. Hence, this study does not include a discussion of these characteristics of school buildings.

The study units, such as study halls, libraries, and the like, are also important considerations. A library especially should be provided in every junior high school. In this study it is taken for granted that at least one library, accommodating in one sitting about ten per cent of the school capacity, should form a part of the facilities of every junior high school. Standards for this unit have been formulated by a committee of the National Education Association.

The study hall is used in some junior high school organizations and not in others. Its use depends on the organization of the school, and consequently differs according to the policies of different communities. Furthermore, the study hall has no effect on the instructional facilities necessary to carry on the school program. For these reasons there is no further consideration of study halls in this monograph.

THE PROBLEM

The problem of this thesis is to determine a scientifically accurate method for computing the number and capacity of in-

structional rooms of different types necessary to house a given junior high school program. In other words, the problem is to evolve a method whereby anyone can accurately translate the junior high school program into building facilities. If this can be done accurately the school program will fit into the building without waste of space and without overcrowding any of the facilities and it will not be necessary to curtail any essential part of the curriculum and force the operation of a program which may not meet the most urgent needs of the community.

Three major questions have been deemed essential to the consideration of this problem. They are as follows:

1.   What needs are there for this sort of study?

2.   What is the method for accurately translating the program into building requirements?

3.   What are the relationships which should exist between the capacity of the well-planned, completely-filled building and the school program?

DATA USED IN THE STUDY

The data for the study consist of the teaching programs from twenty-seven junior high schools as follows:

	School	City	Enrollment
1.	Bloom	Cincinnati	1125
2.	Audubon	Cleveland	1800
3.	Empire	,,	1447
4.	Kennard	,,	1376
5.	Pilgrim	Columbus	784
6.	Broadway	Denver	523
7.	Byers	,,	1249
8.	Gove	,,	962
9.	Grant	,,	464
10.	Morey	,,	1201
11.	Skinner	,,	1290
12.	Barbour	Detroit	1585
13.	Condon	,,	1209
14.	Hutchins	,,	1225
15.	Miller	,,	818
16.	Neinas	,,	724
17.	Denfield	Duluth	426
18.	Irving	,,	359
19.	Lincoln	,,	840
20.	Morgan Park	,,	157
21.	Washington	,,	1028
22.	Strong	Grand Rapids	1044
23.	Madison	Rochester	1471
24.	Memorial	San Diego	1104
25.	Roosevelt	,,	1580
26.	East	Sioux City	655
27.	West	,,	815
	Total		27,261

The programs of these schools represent a total of 780,427 pupil recitation periods per week for a total of 27,261 pupils. Data were secured from three other schools, but seemed to be incomplete and were not included.

Special data relating to room facilities provided were also secured for a number of the schools, especially in Denver, Detroit, and Rochester.

The following is an example of a teacher's program as it was received:

Strong Junior	Grand Rapids	M. Spence	11-9-22
School	City	Teacher	Date

List each class or section separately. Note example. Include all classes. Bracket double periods. See other side for further instructions.

Subject	Number of Pupils by Grade and Semester									Recitation			No. Mo. in Course	Note Laboratory Days
	7B*	7A*	8B	8A	9B	9A	10B	10A	Total	No. of Min.	No. Per Week	Hour of Day		
Examp: Arithmetic	31	3	1						35	45	5	9:00	10	
1. Math.				30					30	45	5	8:34	10	
2. Alg.				32					32	45	5	10:10	10	
3. Math.				27					27	45	5	10:58	10	
4. Alg.				31					31	45	5	1:07	10	
5. Math.				31					31	45	5	2:03	10	
6.														
7.														
8.														

*For the purpose of this report B class shall designate the first semester and the A class the second semester of each grade. If your classification is the reverse of this please note under "Remarks" on other side of this card.

DIRECTIONS (On back of card)

In filling out the form on the other side of this card, be sure to supply all the information designated, such as names of school and city, date, etc. The example shows the entries for a class in arithmetic consisting of 31 pupils from Grade 7, first semester (B), 3 from Grade 7, second semester (A), and 1 from Grade 8B. The recitation is 45 minutes in length, meets five times per week at 9:00 a. m. The arithmetic course is 10 months in length. Follow this example and fill in the data for all your classes. Be sure to bracket double periods.

METHOD OF TABULATION

The cards from several junior high schools were tabulated in order to find a satisfactory form on which all possible school programs could be tabulated. It was found that programs vary from day to day, as some classes meet five times per week, others three times, twice, or only once. The school program of one week is practically like that of any other in the semester. Since a major phase of this study is to evolve a method whereby the school program can be easily converted into building requirements, it is obvious that the tabulation form must include all the varying factors entering into the modern junior high school program. The smallest unit which seems to include every conceivable situation is the schedule of one week. Consequently, it is necessary that the form for tabulation must be capable of recording accurately the weekly schedule taking into account the subjects, the number of pupils, and the number of periods. Such a form is represented in the following tabulation sheet.

Tabulation Sheet — Junior High School Programs

Periods Per Week	Number of Pupils Reciting								Total Pupil Periods*
	10	8	6	5	4	3	2	1	
English									
Latin									
French									
Social science									
Mathematics									
Science									
Art									
Music									
Mechanical Draw.									
Wood Shop									
Metal Shop									
Foods									
Clothing									
Bookkeeping									
Typewriting									
Physical Ed.									

*Total pupil-periods = 10 times the number of pupils reciting 10 periods per week plus 8 times the number reciting 8 periods plus 5 times the number reciting 5 periods and so forth.

As will be seen, on the above form can be tabulated the number of pupils reciting ten, eight, six, five, four, three, two, or one period in each or any subject. Thus the number of pupils reciting five double periods per week is tabulated under 10, four double periods under 8, five single periods under 5, and so forth. From this, the school program may be converted into pupil-periods per week.

Pupil-period may be defined as one pupil in one recitation period. Thus twenty pupils reciting five periods a week would represent 100 pupil-periods. The total pupil-periods in any subject equals 10 times the number of pupils reciting 10 periods, plus 8 times the number of pupils reciting 8 periods, plus 5 times the number of pupils reciting 5 periods, and so forth. This measure, the pupil-periods per week, is extremely convenient in that it is common both to the school program and the building capacity. Direct comparisons on the pupil-period basis are therefore possible, because both school program and building capacity can be converted or translated into pupil-periods. This measure is used in developing the problem as stated above.

CHAPTER II

NEED FOR STUDY

The need for a study of a scientific method of translating a junior high school program into building requirements is based on three conditions: (a) the extreme complexity of junior high school programs; (b) the tremendous differences in the programs in operation; and (c) the lack of balance between buildings and programs in schools recently built and now in use.

COMPLEXITY OF PROGRAMS

Two illustrations will serve to establish the fact that junior high school programs are complex. Table 1 represents the Detroit program in terms of the number of periods per week devoted to each subject in the different curricula. It will be noticed that the seventh grade work is uniform for all pupils, except for the sex differentiation in shop and household arts; and that at the

TABLE 1

PROGRAM OF STUDIES FOR DETROIT INTERMEDIATE (JUNIOR HIGH) SCHOOLS SHOWING NUMBER OF RECITATIONS PER WEEK

	7th Grade		8th Grade				9th Grade			
			Genl.	Tech.		Coml.	Genl.	Tech.		Coml.
	B	A	B.G.	B.	G.	B.G.	B.G.	B.	G.	B.G.
Health	5	5	5	5	5	5	5	5	5	5
Social science	5	5	5	5	5	5	5	5	5	5
English	5	4	4	4	4	4	4	4	4	4
Mathematics	4	4	3	3	2	2	3	3	2	
General science	3	2	2	2	2	2	2	2	2	2
Auditorium	2	2	2	2	2	2	2	2	2	2
Music	1	1	1		1	1	1		1	1
Art and design	1	1	1	1	2	1	1		2	1
Foreign language			5				5			
Cooking, girls	2	3	1		3	1	1		3	
Sewing, girls	2	3	1		3	1	1		3	
Household science, girls					1				1	
Shops, boys	3	5	1	6		1	1	6		
Mech. drawing, boys	1	1	1	2		1	1	3		
Bookkeeping										5
Business practice						5				1
Statistics										2
Typewriting										2
Penmanship						1				
*Totals	30	30	30	30	30	30	30	30	30	30

*Totals corrected for inclusion in column of both boys' and girls' special work.

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beginning of the eighth grade one of three curricula—general, technical, or commercial—may be selected by the pupils. To complicate the program further, there are nineteen subjects in the school curriculum, varying widely in number of periods devoted to each. Social science and health occur five periods per week for all pupils; English occurs five periods for pupils in Grade 7B and four periods for the others; only one period is devoted to art, one to music, and so forth. Foreign languages are studied

TABLE 2

PROGRAM OF STUDIES — JUNIOR HIGH SCHOOLS

Grade	PRESCRIBED WORK	Check Required Subjects	ELECTIVES	Check Electives
7B	English 1J................(5) Social science 1J............(5) Mathematics 1J.............(5) General science 1J.........(3) Art 1J.....................(2) Music 1J...................(3) Industrial arts 1J.........(5) Food in relation to health Health program 1J.........(2)			
7A	English 2J................(5) Social science 2J............(5) Mathematics 2J.............(5) General science 2J.........(5) Art 2J.....................(2) Music 2J...................(1) Industrial arts 2J.........(5) Clothing choice Health program 2J.........(2)			
8B	English 3J................(5) Social science 3J............(5) Mathematics 3J.............(5) Art 3J.....................(1) Music 3J...................(2) Industrial arts 3J.........(5) Home problems Health program 3J.........(2)		Must elect one to complete a normal load. Latin 1J...................(5) French 1J..................(5) Spanish 1J.................(5) Junior business training 1J ....(5)	
8A	English 4J................(5) Social science 4J............(5) Mathematics 4J.............(5) General science 4J.........(3) Art 4J.....................(3) Music 4J...................(2) Health program 4J.........(2)		Must elect one to complete a normal load. Latin 2J...................(5) French 2J..................(5) Spanish 2J.................(5) Junior business training 2J............(5) Industrial arts 4J.........(5) Foods of other peoples or Personal appearance and clothing selection	

TABLE 2 (Continued)

NORMAL PUPIL LOAD IN GRADE 9 IS FOUR UNITS OF CREDIT

Grade	PRESCRIBED WORK	Check Required Subjects	ELECTIVES	Check Electives

9B	English 5J................(5)
	Social science 5J...........(5)
	Health program 5J ......(2)
			Latin 3J.....................(5)
			French 3J....................(5)
			Spanish 3J...................(5)
			Algebra 1J...................(5)
			Biology 1J...................(5)
			Bookkeeping 1J
			  or typewriting 1J........(5)
			Music 5J.....................(3)
			Art 5J.......................(3)
			  Drawing
			  Metalcraft
			  Lettering and printing
			   design
			  Art for school activities
			Industrial arts............(5)
			BOYS
			Home mechanics........(5)
			Industrial arts ....(5)
			Printing ....(5)
			GIRLS
			Personal appearance and
			  clothing selection
			Dinner cookery and hospitality	

9A	English 6J................(5)
	Social science 6J...........(5)
	Health program 6J........(2)
			ELECTIVES
			Latin 4J.....................(5)
			French 4J....................(5)
			Spanish 4J...................(5)
			Algebra 2J...................(5)
			Science (general) 2J......(5)
			Bookkeeping 1J
			  or typewriting 1J........(5)
			Music 6J.....................(3)
			Art 6J.......................(3)
			  Drawing
			  Metalcraft
			  Lettering and printing
			   design
			  Art for school activities
			Industrial arts 6J:
			BOYS
			Home mechanics........(5)
			Industrial arts...........(5)
			Printing ....(5)
			GIRLS
			Clothing and millinery
			  construction
			Dinner cookery and hospitality	

only by those who select the general course, while, on the other hand, all pupils take at least one period in either shop or household arts, with greater amounts assigned to pupils in grade seven and to those selecting the technical curriculum. These facts indicate clearly a complex junior high school program.

Table 2 illustrates another type of complex junior high school program. This is the Denver schedule of studies recently adopted for use by the schools of that city. This program includes subjects which are prescribed and others which are electives. Prescribed and elective subjects and the number of periods per week to be devoted to each subject have been set up for each grade. An examination of the schedule shows conclusively that the program is one of great complexity.

The foregoing examples are typical of the modern development of the junior high school schedule of studies. Further evidence is not brought forth in this study, because the subject has been extensively presented in other works. Davis in his recent book on *Junior High School Education*, Briggs on *The Junior High School*, and Hines on *The Junior High School Curricula* present vast bodies of evidence of the complexity of junior high school programs. It would seem that this fact alone is sufficient justification for a study of scientifically translating the program into building requirements.

JUNIOR HIGH SCHOOL PROGRAMS DIFFER

The fact that junior high school programs vary widely can easily be shown by the proportionate number of pupil-periods per week devoted to different subjects in typical schools. Four schools selected at random from Cleveland, Denver, Detroit, and Rochester

TABLE 3

PUPIL-PERIODS PER SUBJECT IN FOUR TYPICAL JUNIOR HIGH SCHOOLS

Subjects	School A	School B	School C	School D
English	6280	6295	5430	4250
Foreign languages	660	2270	1160	1375
Social sciences	6300	3900	3900	5000
Mathematics	5100	4930	4240	2950
Total classroom subjects	18,340	17,395	14,730	13,575
Science	880	740	2290	2130
Art	1720	1825	1840	985
Music	1175	1230	840	780
Shops	2105	1614	3296	1895
Commercial	805	1015	960	1525

indicate the tremendous variability existing. These schools have varying enrollments of over 1200, consequently pupil-periods in these programs have been converted to a uniform basis of 1000 pupils. Table 3 shows the number of pupil-periods per thousand enrolled in one week in the four schools named above.

Table 3 shows that School A devotes 6280 pupil-periods per week to English, School B 6295, School C 5430, and School D only 4250, a total of 2045 pupil-periods per week less than School B for the same number of pupils. The same variations are indicated for the other subjects taught in the different schools. Since the regular classrooms are and should be used interchangeably, a consideration of the total periods for classroom subjects shows that School D employs 4,765 fewer pupil-periods per week for these subjects than School A. Thus, School A obviously requires more regular classrooms than School D. In the same way School C requires three times the science facilities required by School B, and B requires about twice the art facilities necessary in School D. Similar deductions can be made from this table as to the requirements for other subjects. The evidence seems conclusive that the building requirements of one school do not meet the needs of another, and consequently, no fixed standard number of classrooms, shops, science, art, or music rooms can be set up to fit all types of school programs. The problem is one of the individual adjustment or translation of the school program into building requirements.

HOW BUILDINGS FIT THE NEED

The third question bearing on the need for this study is that of the experiences of the past in translating the educational program, as it will function, into building requirements. It has been found that most buildings are not well adjusted to the program, or, in other words, the building is not balanced in such a way that the program functions economically and efficiently in the building. Comparisons of the number of pupil-periods in the capacities provided in the building for each of the different activities with the number of pupil-periods in the corresponding activities of the educational program show how well the translations have been made.

Capacity as used in this study must be defined. Any school building has two capacities; one may be called the absolute capacity and the other the instructional capacity. The absolute capacity

is the capacity which enumerates every possible pupil station in the building during the day or week. As has been stated, all data herein are for the week. When comparing the building with the program the absolute capacity is used. Capacity is discussed at greater length in a later section of this study.

To show clearly that the modern junior high school building does not fit the program, Diagrams I and II are presented. These show the relationship between the capacities provided for the different school activities in two buildings erected since the end of the World War and the actual school programs in operation. School A represented in Diagram I was supposedly built for 800 pupils, but at the time of this survey actually housed 1250 pupils. The diagram should be read as follows: The library has an absolute capacity of 1800 pupil-periods per week, and 2641 pupil-periods are scheduled for this room, or 147 per cent of the absolute capacity; the classrooms have an absolute capacity for 23,980 pupil-periods, and the school program provides 21,581 pupil-periods, or 91 per cent of the absolute capacity.

DIAGRAM I

COMPARISON OF ABSOLUTE CAPACITY AND ATTENDANCE IN SCHOOL A

SUBJECT	WEEKLY CAPACITY	WEEKLY ATTENDANCE	PER CENT
LIBRARY	1,800	2,641	147
CLASSROOMS	23,980	21,581	91
HOME ECONOMICS	2,460	2,222	90
SCIENCE	1,200	925	77
MUSIC	2,100	1,539	73
GYMNASIUM	3,600	2,397	67
ART & M.D.	4,350	2,874	66
COMMERCIAL	2,640	1,269	47
MANUAL TRAINING	3,870	1,784	46
PRINTING	600	229	38
TOTAL	46,500	37,461	80

The diagram shows clearly the relationship existing between the school program and the building. Library facilities are inadequately provided for; the classrooms and home economics department seem to be well filled; while the commercial, manual training, and printing rooms are used less than 50 per cent of the capacity.

It is interesting to note that this building erected for 800 pupils was used at only 80 per cent of the absolute capacity when housing 1250 pupils.

Diagram II shows practically the same situation in a much larger school. School B was planned for 2000 pupils. While the school at the time of this survey had only 1800 pupils, the pupil-periods for each activity are increased to represent the same program for 2000 pupils. This was accomplished by multiplying the pupil-periods by 2000/1800 or 1.11. The comparisons shown in Diagram II are therefore between the absolute capacity provided for 2000 pupils and the pupil-periods in the school program for the same number of pupils.

DIAGRAM II

COMPARISON OF ABSOLUTE CAPACITY AND ATTENDANCE IN SCHOOL B

SUBJECT	WEEKLY CAPACITY	WEEKLY ATTENDANCE	PER CENT
Shops	6,300	6,592	105
Art	4,200	3,680	88
Classrooms	36,750	29,500	80
Music	2,100	1,680	80
Science	6,300	4,580	73
Mech. Drawing	2,100	1,040	50
Library	3,000	1,440	48
Phys. Edu.	5,400	2,520	46
Commercial	5,250	2,030	39
Home Economics	9,900	2,982	30
Total	78,300	54,604	70

' The diagram shows that shops are used at 105 per cent of the capacity, while at the other extreme the home economics laboratories are used at only 30 per cent. Five departments show use amounting to 50 per cent or less of the capacity provided. Classrooms function at 80 per cent, and the building as a whole at only 70 per cent. In other words, this building is not adjusted economically to the program in operation, and it may be surmised that the actual pupil capacity is considerably over 2000.

Many examples such as these can be cited, but it seems that these two typical examples of modern junior high school planning from different parts of the United States demonstrate clearly that no scientific or even approximately accurate methods have been employed in making plans for housing the junior high school program.

CONCLUSION

The foregoing facts indicate clearly that the problem of providing the correct number of rooms for each of the junior high school activities is a difficult one due to the extremely complex programs now in operation, that it cannot be done by a standard list of room requirements, and that the problem is not met in actual practice. They also reveal quite clearly the other important problem which bears directly on the relationship between the absolute capacity and the school program. In other words, there seems to be real need for a more accurate method for determining junior high school requirements. A formula which can be applied quickly, easily, and accurately by school officials would probably fill the need.

CHAPTER III

DATA NECESSARY IN COMPUTING ROOM REQUIREMENTS

Since it is the purpose of this study to set up the requirements for a building which will efficiently and adequately house a given junior high school program, it seems obvious that the school program must be fully determined in all its details before it is possible to proceed further in setting up the room requirements. The most important features of the school program which affect the number of rooms to house the program are as follows:

1. Program of studies
2. Number of recitations per week in each study
3. Number of pupils in each study or subject
4. Number of recitation periods in the school day or week
5. Average size of classes

There are other factors entering into the making of school programs, such as length of periods, extra-curricular activities, and the like, but they do not affect room requirements and therefore have no bearing on the problem. The preparation of the school program in definite and workable form is the first step in formulating junior high school room requirements.

PROGRAM OF STUDIES

Little needs to be said about the program of studies, as it seems obvious that such a program must be set up. It is probably not necessary to mention the fact that no standard schedule of studies which will fill the needs of all cities or communities can be devised. Needs of different communities vary too widely for such a possibility. The fact that programs actually differ greatly has been conclusively demonstrated. It seems that each city has followed the practice of formulating its programs, and there is no evidence that it should do otherwise. No accurate room requirements can be determined without first setting up a program of studies, which must be developed by each city to fit its particular educational needs.

NUMBER OF RECITATIONS PER SUBJECT

The number of recitations to be devoted to each subject per week goes hand in hand with the development of the program of studies. In fact no program can be set up without determining simultaneously the number of periods per week which will be assigned to each subject in the proposed curriculum. This also is a problem of the individual community.

NUMBER OF PERIODS IN SCHOOL DAY OR WEEK

The number of recitation periods per day varies from five to nine in the twenty-seven junior high schools studied, or from 30 to 45 per week. Six periods per day or 30 per week seems to be the most common practice. The number of periods is an important factor in determining room requirements, because the rooms vary in number inversely as the number of periods in the school day, or the greater the number of periods the smaller the number of classrooms for a school of a given size.

Up to date, there is no obtainable evidence for or against a certain number of class periods per day or week. It seems, however, that this is a problem which has a demonstrable solution. Until definitely solved it rests upon each community to determine its policy with regard to the number of periods in the school day.

AVERAGE SIZE OF CLASSES

The practice in different cities with regard to the size of classes varies tremendously. It is not uncommon to find classes with 15 pupils and others with 45 pupils in the same subject in the same school. The average size of classes in one junior high school may be 22 and in another 32 or more. The question of the most efficient size does not belong in this study. In this field P. R. Stevenson of Ohio State University has done the most outstanding work in attemping to evaluate scientifically the efficiency of instruction in large classes as compared with the efficiency of instruction in small classes. So far the results are significant in pointing out that small classes are not more efficient than larger ones. But as yet the results are not conclusive, and for this reason the policy of the size of classes must be adopted by the individual communities. Precautions must be taken to make construction flexible so that the size of rooms may be altered to meet possible future changes in size of classes.

PROBABLE NUMBER OF PUPILS IN EACH SUBJECT

There seems to be only one known method of preparing estimates for the probable number of pupils who will be enrolled in each subject. This method is to tabulate the number of pupils in each subject in an existing organization similar to the one contemplated. Such estimates will furnish fairly accurate data for computing the number of schoolrooms required. Precautions must be taken to see that the programs are alike as nearly as possible. Estimates of the effects of changes in the program, if any, must be made. For instance, if the science program is to be enlarged it will be necessary to estimate the effect of this change in the number of pupils who will take the subject. This is easily done if one has available the grades in which the subject will be required or elected. This distribution of pupils by grades is fairly well known in any system of schools and will form an approximately accurate basis for estimating changes from an existing organization. In Denver, for example, science was taught in only one semester of the ninth grade. In the new schedule all pupils in grades seven and eight will be required to take general science. Thus, the new program will require science rooms for these grades in addition to the ninth. In other words, in a school of 1200, instead of 200 pupils enrolled, there will be about 800 additional pupils or 1000 in all. Similarly, any changes in the program can be estimated with a fair degree of accuracy. Thus, the utilization of pupil distribution by subjects in existing schools similar in organization and serving like communities, with corrections as described, is the method used in this study.
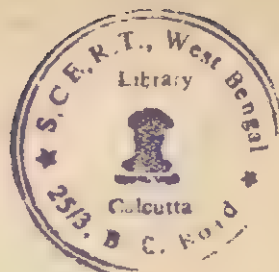
CHAPTER IV

FORMULA FOR TRANSLATING THE SCHOOL PROGRAM INTO ROOM REQUIREMENTS

The last step in computing the number of rooms required is to translate a fairly definitely known school program into the number of rooms of each type necessary to house it. The known factors in the program which enter into the formulation of room requirements, if the policies of organization have been determined, the program of studies adopted, and the distribution of pupils ascertained, are as follows:

1. Subjects in the curriculum
2. Number of periods per week for each subject
3. Number of pupils taking each subject
4. Number of periods in school week
5. Average size of classes

As has been shown, the unit which is common to both school program and school capacity is the pupil-period (PP). Factors 1, 2, and 3 provide for the conversion of the school program into pupil-periods. An illustration will make this clear. In English suppose there are 800 pupils reciting 5 times per week and 200 reciting 2 times per week. Thus, the PP in English $= (5 \times 800) + (2 \times 200) = 4400$. A formula which would hold for any given subject would be derived as follows:

Let $n =$ number of pupils.
Let $10n =$ number of pupils reciting 10 periods per week.
Let $8n =$ number of pupils reciting 8 periods per week.
Let $6n =$ number of pupils reciting 6 periods per week.
Let $5n =$ number of pupils reciting 5 periods per week.
Then, the PP for any given subject will be:

$$10n + 8n + 6n + 5n + \ldots \ldots \ldots n.$$

In applying this formula if no pupils recite 10 periods or 8 periods, $10n$, or $8n$, would be dropped out of the computation.

Having determined the number of pupil-periods in any given subject, the process of finding the number of rooms required is simple. Three additional factors must be introduced: number of periods in the school week, the average size of class, and the allow-

ance for schedule making. Periods per week times the average size of class gives the pupil-period instructional[1] capacity of the average classroom. Thus the pupil-periods of recitation in any given subject divided by the average pupil-period capacity of the classroom will yield the number of rooms required without providing any allowance for the making of the schedule. The formula for the procedure so far is as follows:

$$\text{Number of classrooms required} = \frac{10n + 8n + 6n + 5n + \ldots n}{\substack{\text{average size} \\ \text{of class}} \times \substack{\text{number of periods} \\ \text{per week}}}$$

Simplified the formula reads

$$\text{Number of classrooms required} = \frac{\text{PP in subject per week}}{\text{average PP per week in classroom}}$$

In other words, without making the allowance for the schedule, the number of rooms required in any subject is found by dividing the number of pupil-periods per week in the subject by the average number of pupil-periods which can be accommodated in the classrooms.

The formula derived above, if applied to an actual situation, requires that all classrooms so determined be occupied every period of the week, which obviously is an impossibility, due to the difficulties of making junior high school schedules to use school rooms one hundred per cent of the time. If S be used as a symbol for the allowance to be made, S represents the per cent of the total number of classroom periods unoccupied during the week. This unoccupied portion is the allowance in number of classrooms over and above the number which would function at 100 per cent with the same program. In other words, 1 minus S represents the per cent of the total number of classroom periods occupied during the week. The allowance for the schedule should be included in the denominator of the above formula as a third multiplier in the form of the per cent of possible occupancy in a well-organized school, or 1 - S. The formula with allowance would be as follows:

$$\text{Number of rooms} = \frac{\text{PP per week in subject}}{\substack{\text{average class} \times \text{number of periods} \times (1\text{-}S) \\ \text{per week}}}$$

The values of S will be determined in Chapter V.

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[1] Instructional capacity makes allowances for program making and is somewhat less than the absolute capacity. See pages 23 ff.

CHAPTER V

ALLOWANCES FOR SCHEDULE MAKING

In order to make a junior high school schedule, two allowances in determining the room requirements must be made.

1. An allowance in the number of rooms, that is, S.

This was discussed in the latter portion of Chapter IV. The value of this allowance, or S, will be determined in this chapter.

2. An allowance in capacity of rooms in excess of the average class.

The amount or value of this factor will be determined in the latter part of this chapter.

THE DATA AND METHOD

The only available method for determining the allowances to be made for schedule making is to accept as the standard the use of buildings in which school programs seem to be best organized from the standpoint of the efficient use of the buildings, and at the same time are realizing the modern socialized junior high school ideal.

To solve the problem of allowances for schedule making, a study has been made of the programs of three selected schools with 500 pupils, 1000 pupils, and 1500 pupils, respectively. It was necessary to select schools for this phase of the study with enrollments which seemed to fill the buildings to the point of overcrowding, and in which there were in operation school programs that did not seem to lessen the efficiency of instruction in the classrooms. Fortunately three junior high schools in Denver seemed to furnish ideal situations for this study. These three schools were selected after careful study of the relationship existing between capacities and junior high school programs in Detroit, Denver, Cleveland, and Rochester.[1] The schools selected seem to give the best available data bearing on the problems of schedule allowances in number and capacity of instructional rooms, and, as in any other science, the conclusions will stand until more and better data which lead to other conclusions have been produced.

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[1]From unpublished studies made in connection with building programs at Detroit and Denver.

Diagram III shows the occupancy and vacancy of instructional rooms occurring in School A, which has approximately 500 pupils in attendance. The diagram shows graphically that the making of the program in this school is effective, and that it must be made with practically no waste of space. Diagram IV shows the same for School B, which has approximately 1000 pupils in attendance. The number of vacant rooms occurring during the week shows again that this building is used very efficiently and that the program has been exceptionally well planned. The same conclusions can be drawn from Diagram V regarding the program in School C, with about 1500 pupils. Diagram VI is presented as additional data on the efficiency with which the three buildings shown in Diagrams III, IV, and V are used. The building represented housed at the time of the survey about 1425 pupils, and functioned at 66.2 per cent. The contrast with the three buildings selected as standards for this study is great enough to show that the schedules represented in Diagrams III, IV, and V have been well planned, and that the buildings are effectively used.

In addition to these diagrams three tables are presented, which show that Schools A, B, and C are operating at relatively high rates of efficiency. Few school buildings have been found in which the school program in terms of pupil-periods per week exceeds 75 per cent of the absolute capacity also in terms of pupil-periods per week. These three buildings function at 75 per cent or better.

DIAGRAM III

Occupancy (in black) and Vacancy (in white) of Rooms in School A

DIAGRAM IV

Occupancy (in black) and Vacancy (in white) of Rooms in School B
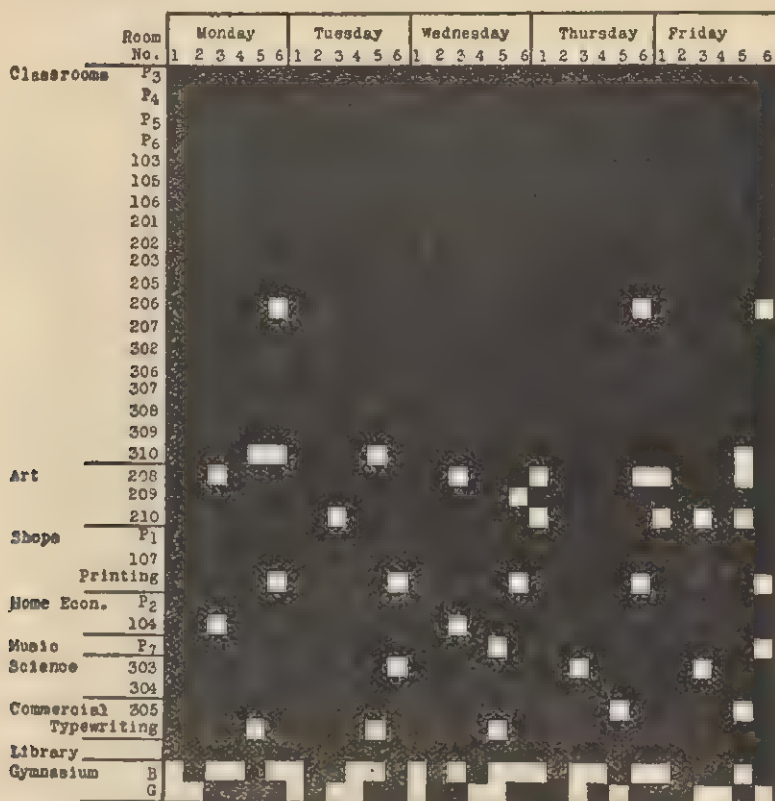
TABLE 4

RELATIONSHIP BETWEEN CAPACITY AND PROGRAM IN SMALL JUNIOR
HIGH SCHOOLS

SCHOOL OF 500 PUPILS (A)

Type of Rooms	Pupil-Periods Per Week		Per Cent Program is of Capacity
	Capacity	Program	
Art	1,050	874	83.2
Manual training	840	689	82.0
Commercial	1,020	811	79.5
Classrooms	8,860	6,858	77.4
Gymnasium	1,200	900	75.0
Study	2,700	1,838	68.1
Household arts	960	539	56.2
Printing	180	85	47.2
Total	16,810	12,594	74.7
Classrooms	8,860	6,858	77.4
Special rooms*	7,950	5,736	72.2

*Laboratories, shops, art rooms and so forth.

Table 4 shows the comparison between the program and the capacity, both reduced to pupil-periods per week, in School A, which houses 500 pupils.

DIAGRAM V

Occupancy (in black) and Vacancy (in white) of Rooms in School C

The table shows that art with a capacity of 1050 pupil-periods per week accommodates 874 pupil-periods, which is 83.2 per cent of the capacity. From the table it is evident that with the exception of two rooms the building is well used. The building as a whole functions at 74.7 per cent of its absolute capacity.

DIAGRAM VI

Occupancy (in black) and Vacancy (in white) of Rooms in a Typical
Junior High School

This is probably a high rate, when the size of the school and the scarcity of vacant rooms in the building are considered. (See Diagram IV).

Table 5 shows the same for School B, a medium-sized junior high school, except that this school operates at nearer capacity; namely, 86.7 per cent.

<div align="center">

TABLE 5

RELATIONSHIP BETWEEN ABSOLUTE CAPACITY AND PROGRAM IN MEDIUM-SIZED
JUNIOR HIGH SCHOOLS

SCHOOL OF ABOUT 1000 PUPILS (B)

</div>

Type of Rooms	Pupil-Periods Per Week		Per Cent Program is of Capacity
	Capacity	Program	
Music	1,500	1,434	95.6
Classrooms	19,080	17,740	93.0
Gymnasium	2,250	2,008	89.2
Home economics	1,620	1,383	85.4
General science	2,160	1,835	85.0
Library	1,260	1,069	84.8
Manual training	1,440	1,200	83.4
Printing	420	293	69.8
Art	3,060	1,924	62.9
Commercial	1,800	1,107	61.5
Total	34,590	29,993	86.7
Classrooms	19,080	17,740	93.0
Special rooms	15,510	12,253	79.0

All parts of the building are well used, no room housing less than 61.5 per cent of its absolute capacity. The fact that the building is used 86.7 per cent of the capacity in a fairly well balanced manner, with very few vacant rooms as shown in Diagram V, makes this building an excellent standard for determining the allowances which should be made for schedule making in schools with 800 to 1200 pupils.

Table 6 shows how well the large school of 1500 pupils should operate. The per cent the program is of capacity is higher in the large school than in the smaller schools. The table shows this clearly. It shows also that the program more nearly fits into all parts of the building. In this case, the lowest ratio between program and capacity is 65.8 per cent, which in itself is relatively high in most schools. The building as a whole operates at 89.4 per cent, which is probably as high as any school can function without depreciating the junior high school program.

These data are presented with a view to showing conclusively that the schedules in these three schools have been so efficiently planned that there can be no question about their value in determining standard relationships which should exist between the absolute capacity of a building and the school program in well-planned schools. In other words, it seems that these buildings are

TABLE 6

RELATIONSHIP BETWEEN ABSOLUTE CAPACITY AND PROGRAM IN LARGER JUNIOR HIGH SCHOOLS

SCHOOL OF ABOUT 1500 PUPILS (C)

Type of Rooms	Pupil-Periods Per Week		Per Cent Program is of Capacity
	Capacity	Program	
Classrooms	23,880	22,957	96.1
Home economics	2,520	2,420	96.0
Shops	3,690	3,424	92.8
Art	3,150	2,870	91.1
Science	2,250	1,969	87.5
Library	1,800	1,545	85.8
Printing	600	430	71.6
Music	1,800	1,282	71.2
Physical education	4,200	2,837	67.5
Commercial	2,000	1,316	65.8
Total	45,890	41,050	89.4
Classrooms	23,880	22,957	96.1
Special rooms	22,010	18,093	82.2

almost ideal for the purpose of determining the allowances both in the number and the capacity of classrooms.

The schools represent three distinct sizes of junior high schools. School A may be taken as a type to represent the small school varying from four hundred to seven or eight hundred; School B to represent the school varying from eight to twelve hundred. School C represents the group of larger schools with twelve to eighteen hundred pupils. No reliable data of similar character have been found for schools having two thousand or more pupils, but it is probable that School C may be used tentatively as the standard for schools in excess of 1800 pupils. It seems, therefore, that the standards derived from a study of building use in these three schools will serve adequately for schools of eighteen hundred pupils or less, and tentatively for larger schools.

ALLOWANCES IN THE NUMBER OF ROOMS OR THE VALUE OF S

The number of rooms in excess of the number at which the occupancy of rooms would be 100 per cent is the allowance which must be made for schedule making. The three schools described form the basis for conclusions as to the allowances to be made for schools varying in size from 500 to 1800 pupils. In these schools the vacant rooms represent the excess over 100

per cent use. Table 7 shows the number of vacant rooms during the week in regular and special classrooms.

TABLE 7

Number and Per Cent of Vacant Rooms Per Week

	Regular Classrooms*			Special Rooms†		
		Vacant			Vacant	
	Total Available	Number	Per Cent	Total Available	Number	Per Cent
School A Small school	270	0	0	240	27	11.3
School B Medium school	570	7	1.2	450	35	7.8
School C Large school	690	6	.9	570	28	4.9

* Regular classrooms are those used for mathematics, foreign languages, English, social sciences, etc. † Special rooms are those used for laboratories, shops, etc.

The table shows practically none of the classrooms vacant during the week in any of the schools. Vacancies, however, occur in the special classrooms, such as science, art, shop, commercial, and household art rooms. The data seem to indicate clearly that no allowance need be made for classrooms other than to use the whole number when the number of rooms required comes out in fractional form. Thus if the classrooms required figures 18.2, nineteen classrooms would be provided. In addition to this allowance, special rooms should be so equipped that academic classes can be accommodated in them under stress. In other words, the allowance for schedule making in regular classrooms, when applying the formula, would consist of using the next highest whole number instead of the fraction, and providing flexibility of use in special classrooms. Thus the allowance for schedule making in regular classrooms, or the value of S, would be zero.

For special rooms the factor of the schedule is important. In small schools, (see Table 4) 11.3 per cent of the classrooms were vacant during the week; in medium-sized schools, 7.8 per cent; and in large schools, 4.9 per cent.

It may be concluded from these data that the per cent of vacancy of rooms is due to the impossibility of organizing a schedule to use special classrooms 100 per cent. In other words, the making of schedules for special subjects requires certain amounts of extra space, varying with the size of the school. The per

cent of vacant rooms therefore provides the allowances which should be made in the number of special rooms to care for the requirements of schedule making in junior high schools.

These allowances (S) are as follows:

Small schools, S = .12
Medium schools, S = .08
Large schools, S = .05

ALLOWANCES FOR CAPACITY OF ROOMS

The second allowance which must be made is for the difference between the size of class and the pupil capacity of the classroom. Before the number of rooms of different types can be accurately determined, it is necessary to establish the relationship which should exist between the classroom capacity and the average size of classes. If the rooms were built to carry exactly the same number of pupils as the average class, obviously the number of rooms would not be adequate to take care of the school program. In other words, the capacities of the different types of rooms in a junior high school building must be large enough to permit the satisfactory making of the operating schedule. This section, therefore, deals with the problem of discovering what classroom capacities must be provided to house a given required program.

The data for the solution of this problem are taken from Schools A, B, and C. These data show clearly the relationship between the average capacity of classrooms of different types and the average size of classes. The differences existing between the two represent accurately the allowances which should be made in the capacity of the rooms over and above the average size of class in order to enable the preparation of schedules which would operate with the maximum of efficiency. In other words, the formula which would give the correct capacity figure would be as follows:

$$\text{Capacity} = \frac{\text{average size of class}}{1.00 - \text{allowance}}$$

SMALL SCHOOLS

Table 8 shows the relationship between the average capacity of classrooms and the average size of class in School A with 500 pupils.

TABLE 8

RELATIONSHIP BETWEEN CAPACITY AND SIZE OF CLASS, SMALL SCHOOL

	Average Capacity	Average Class	Per Cent Class Is of Capacity	Allowance for Schedule
Regular classrooms	32.0	25.4	80	.20
Special rooms	32.0	25.6	80	.20

The table shows that the average capacity of regular classrooms is 32.0 pupils, while the average size of class operating in these rooms is 25.4 or 80 per cent of the capacity, or the average class is actually 20 per cent smaller than the capacity of the average classroom. In other words, the 20 per cent represents the allowance which must be made for the preparation of the schedule.

Therefore the complete formula for finding the average pupil capacity of classrooms is as follows:

$$\text{Average capacity of classrooms} = \frac{\text{average size of class}}{1.00 - .20}$$

By the same reasoning the average size of special rooms can be determined. The formula is as follows:

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .20}$$

SCHOOLS OF MEDIUM SIZE, 800 TO 1200 PUPILS

Table 9 shows the relationship between the average capacity of regular and special classrooms and the average number of pupils in the classes of School B, which enrolled 1000 pupils, and represents schools with from 800 to 1200 pupils.

TABLE 9

RELATIONSHIP BETWEEN CAPACITY AND SIZE OF CLASS, MEDIUM-SIZED SCHOOL

	Average Capacity	Average Class	Per Cent Class Is of Capacity	Allowance for Schedule
Regular classrooms	33.5	31.5	93	.07
Special rooms	31.6	26.3	84	.16

The table shows that the average number of pupils in classes reciting in the regular classrooms is 93 per cent of the capacity, an allowance of 7 per cent. It shows also that the average class in special rooms is 84 per cent of the capacity of the rooms, requiring an allowance of 16 per cent for the schedule. Thus the formulas for computing the capacity of classrooms for medium-sized schools are as follows:

$$\text{Average capacity of regular classrooms} = \frac{\text{average size of class}}{1.00 - .07}$$

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .16}$$

LARGE SCHOOLS, 1200 PUPILS AND OVER

Table 10 shows the average pupil capacity of rooms and the average number of pupils in classes, both regular and special, in School C, with 1500 pupils.

TABLE 10

RELATIONSHIP BETWEEN CAPACITY AND SIZE OF CLASS, LARGE SCHOOL
1200 PUPILS AND OVER

	Average Capacity	Average Class	Per Cent Class Is of Capacity	Allowance for Schedule
Regular classrooms	34.6	33.6	96	.04
Special rooms	34.9	31.3	90	.10

By treating these data in the same way as for small and medium-sized schools, the formulas for determining the capacities required to support any given class size would be as follows:

$$\text{Average capacity of regular classrooms} = \frac{\text{average size of class}}{1.00 - .04}$$

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .10}$$

SUMMARY

Based on the findings of the requirements for schedule making it is necessary to make two allowances. First, the making of the junior high school schedule requires a certain number of classrooms over and above the number which would be occupied 100 per cent. This allowance, called S, is included in the formula for determining the number of rooms required to house the junior high school program.[2] The values of S were determined in this chapter and are as follows:

	Regular Classrooms	Special Rooms
Small school, less than 800	$S = 0$	$S = .12$
Medium school, 800 to 1200	$S = 0$	$S = .08$
Large school, 1200 to 1800	$S = 0$	$S = .05$

[2] Formula is no. of rooms $\dfrac{\text{PP per week in subject}}{\text{average size of class} \times \text{periods per week} \times (1 - S)}$

Second, the making of the junior high school schedule requires that the classrooms be somewhat larger in capacity than the number of pupils in the class of average size. The average size of class is one of the known factors in determining room requirements.[3] This chapter has derived the following formula for determining capacities of junior high school rooms. The formula is as follows:

$$\text{Capacity of room} = \frac{\text{average size of class}}{1.00 - \text{the allowance for schedule making}}$$

The allowances for schedule making are as follows:

	Regular Classrooms	Special Rooms
Small school	.20	.20
Medium school	.07	.16
Large school	.04	.10

[3] Chapter III.

CHAPTER VI

PRACTICAL APPLICATION

This chapter attempts to make practical application of the use of the formula derived in this study for determining the number of rooms required to house a given junior high school program, and of the formula for determining the pupil capacity of classrooms when the average size of class has been determined.

DETERMINING THE NUMBER OF ROOMS

Data received from Detroit, Michigan, intermediate (junior high) schools are used in making a practical application of the use of the formula for determining the number of rooms.

Table 11 shows the number of pupils reciting in each subject, and the number of periods per week devoted to the subjects.

TABLE 11

Total Number of Pupils Taking Each Subject and Number of Recitations Per Week — Detroit

Total Number of Pupils—5,561

Periods	Number of Pupils						Pupil Periods
	6	5	4	3	2	1	
English		1,806	3,755	64			24,212
Foreign language		1,503					7,515
Social science		5,561					27,805
Mathematics			1,806	3,343			17,253
General science				1,806	3,819		13,056
Art					320	4,905	5,545
Music						4,625	4,625
Auditorium					5,625		11,250
Shops	936	926				904	11,150
Mechanical drawing				326	674	1,717	4,043
Home economics	1,200				1,232		9,664
Bookkeeping		476					2,380
Business practice		618					3,090
Typewriting		476					2,380
Health		5,561		64			27,997

The table should be read as follows: 1806 pupils out of a total of 5561 recite 5 periods per week, 3755 recite 4 periods, and 64 only 3 periods, or a total of 5625 pupils[1] out of 5561 in

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[1] Thirty-two pupils are enrolled in two English subjects.

35

the school are enrolled in English. The rest of the table is read in the same way. Applying the formula for finding pupil-periods, we have

$PP = 5n + 4n + 3n = (5 \times 1806) + (4 \times 3755) + (3 \times 64) = 24,242.$

In other words, the English program requires 24,242 pupil-periods per week for 5561 pupils in the schools. The programs for the rest of the subjects would be reduced to pupil-periods in the same way. Obviously, it would not be probable that anyone would provide facilities for a school of 5561 pupils. The next step, then, is to reduce the pupil-periods for 5561 pupils computed from Table 11 to pupil-periods for a school of the size required. Suppose that the school to be built is for 1000 pupils. The pupil-periods in each subject in a school of this size would be $\frac{1000}{5561}$ of the pupil-periods in Table 11.

Reduced, the pupil-periods per 1000 would be as shown in Table 12.

TABLE 12

DETROIT PROGRAM CONVERTED TO PUPIL-PERIODS PER 1000 PUPILS

Subject	Pupil Periods
English	4,308
Foreign languages	1,335
Social science	4,925
Mathematics	3,050
Total academic	13,618
General science	2,320
Art	936
Music	820
Auditorium	2,000
Shops	1,948
Mechanical drawing	718
Home economics	1,714
Bookkeeping	420
Business practice	740
Typewriting	420
Health	4,970

Thus English would have 4308 PP per week, foreign languages 1335 PP, social science 4925 PP, and so forth, or a total of 13,618 in all the academic work.

For clarity the formula for computing the number of rooms required is restated at this point:

$$\text{Number of rooms} = \frac{\text{PP per week in subject}}{\text{average class} \times \text{periods per week} \times (1 - S)}$$

Suppose that the average class in the academic work has been fixed at 32 pupils, and that there are 30 periods per week. Since classrooms can be used interchangeably for academic work, the number of rooms can be found for the entire group of academic subjects in one process; or

$$\text{the number of classrooms} = \frac{13,618}{32 \times 30 \times (1-S)} = \frac{13,618}{960} = 14.2$$

S in this case equals 0.

The actual number of classrooms required for academic work is 14.2, but since a fraction of a room cannot be built the number required would be 15 classrooms.

Take as another illustration the shop requirements. Suppose that classes average 24, and that there are 30 periods in the school week. Then,

$$\text{number of shops} = \frac{1948}{24 \times 30 \ (1-S)} = \frac{1948}{720 \times .92} = 2.9 \text{ or } 3.$$

In exactly the same way the number of rooms for any activity can be computed. This has been done for all the subjects and the results are shown in Table 13.

TABLE 13

NUMBER OF ROOMS REQUIRED FOR A JUNIOR HIGH SCHOOL OF 1000 PUPILS, BASED ON THE DETROIT PROGRAM WHICH HAS A 30 PERIOD WEEK

Subject	PP	÷	Average Periods per Class × Week × (1-S)			=	Number of Rooms	Use
Academic	13,618	÷	(32	× 30)	× 1.00	=	14.2	15
General science	2,320	÷	(32	× 30)	× .92	=	2.6	3
Art	968	÷	(32	× 30)	× .92	=	1.1	2
Music	820	÷	(32	× 30)	× .92	=	.9	1
Auditorium	2,000	÷	(70	× 30)	× .92	=	1.0	1
Shops	1,948	÷	(28	× 30)	× .92	=	2.5	3
Mechanical drawing	718	÷	(30	× 30)	× .92	=	.9	1
Home economics	1,714	÷	(28	× 30)	× .92	=	2.2	3
Bookkeeping	420	÷	(32	× 30)	× .92	=	.4	
Business practice	710	÷	(32	× 30)	× .92	=	.8	2
Typewriting	420	÷	(32	× 30)	× .92	=	.4	
Health	4,970	÷	(80	× 30)	× .92	=	2.1	2

DETERMINING THE CAPACITY OF ROOMS

In order to simplify and clarify the application of the formulas for computing the pupil capacity which should be provided in regular and special classrooms, Table 14 has been prepared. This table gives the capacities which should be provided for classes of given average size. The table includes the capacity

of rooms for average classes ranging in size from 15 to 40 pupils, which probably includes all the present day averages for junior high school classes. The capacities are derived from the formula

$$\text{Capacity} = \frac{\text{average size of class}}{(1.00 - \text{allowance})}$$

The allowances are:

	Regular Classrooms	Special Rooms
Small school, below 800	.20	.20
Medium school, 800 to 1200	.07	.16
Large school, 1500 and over	.04	.10

TABLE 14
ABSOLUTE CAPACITY OF CLASSROOMS WHEN AVERAGE SIZE OF CLASS IS KNOWN

Average Size of Class	Capacities To Be Provided					
	Small School 500		Medium School 1000		Large School 1500	
	C. R.	Special	C. R.	Special	C. R.	Special
15	19	19	16	18	16	17
16	20	20	17	19	17	18
17	21	21	18	20	18	19
18	23	23	19	21	19	20
19	24	24	20	23	20	21
20	25	25	22	24	21	22
21	26	26	23	25	22	23
22	28	28	24	26	23	24
23	29	29	25	27	24	26
24	30	30	26	29	25	27
25	31	31	27	30	26	28
26	33	33	28	31	27	29
27	34	34	29	32	28	30
28	35	35	30	33	28	31
29	36	36	31	35	30	32
30	38	38	32	36	31	33
31	39	39	33	37	32	34
32	40	40	34	38	33	36
33	41	41	35	39	34	37
34	43	43	37	40	35	38
35	44	44	38	42	36	39
36	45	45	39	43	38	40
37	46	46	40	44	39	41
38	48	47	41	45	40	42
39	49	49	42	46	41	43
40	50	50	43	48	42	44

The foregoing table shows the number of pupils to provide for in each classroom or special room for any size of class averaging from 15 to 40 pupils. If classes are to average 15 pupils in a school of five hundred pupils, both the regular and the special classrooms should be built for at least 19 pupils. In a school

of one thousand pupils, if the academic classes are to average 28 pupils, classrooms should be built for 30 pupils and special rooms for 33 pupils; or if special room classes are to average 24 pupils, the special rooms should be built to accommodate 29 pupils.

Thus, after the policy in regard to size of classes has been determined, Table 14 presents in easy form the number of pupils to be provided for in classrooms or special rooms in small, medium, and large schools.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The junior high school has become one of the most important institutions in American education. Practically all progressive cities, towns, or villages are erecting buildings to house the program of this type of school.

It is impossible to set up a standard list or even standard lists of room requirements which will fit the needs for any school of given size in any locality. The only practical possibility is to evolve a workable method for determining the number of rooms needed. This method must fit any program in any city, or any school, whatever its size may be. The chief reason for this conclusion is the fact that junior high school programs are not alike in all cities, and the programs within a city do not always require the same facilities.

The problem of determining the housing facilities for this organization is not simple. In fact the complex junior high school programs make it a problem requiring the application of scientific methods if the program is to be accurately translated into the required school building facilities.

This study has evolved a method for determining the housing requirements of junior high school programs. This method can be used in any situation. Each step in the procedure has been explained and a formula, which embodies all factors necessary to the process, has been determined. The formula is as follows:

$$\text{Number of rooms} = \frac{10n + 8n + 6n + 5n + 4n + 3n + 2n + n}{\frac{\text{average size}}{\text{of class}} \times \frac{\text{number of periods}}{\text{per week}} \times (1 - S)}$$

or

$$\text{Number of rooms} = \frac{\text{PP per week in subject}}{\frac{\text{average size}}{\text{of class}} \times \frac{\text{number of periods}}{\text{per week}} \times (1 - S)}$$

A tabulation sheet to aid in the use of the formula is presented on page 8. The values of S vary with the type of room and size of school. These values are as follows:

	Small School	Medium School	Large School
Regular classrooms	0	0	0
Special rooms	.12	.08	.05

This study has also shown that there are definite relationships between the pupil capacity of the classroom or laboratory and the size of the classes which can operate in them. In other words, the maker of a junior high school schedule must have a leeway or an allowance which will make it possible for him to make a workable schedule. It was found in this study that this allowance is definitely related to the average size of class. In small schools the allowances made must be greater than in larger schools. Greater allowances must also be made for special rooms than for regular classrooms. The capacities which should be provided, the policy concerning average size of classes having been determined, are as follows:

Small Schools, 500 Pupils

$$\text{Average capacity of regular classrooms} = \frac{\text{average size of class}}{1.00 - .20}$$

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .20}$$

Medium-sized Schools, 1000 Pupils

$$\text{Average capacity of classrooms} = \frac{\text{average size of class}}{1.00 - .07}$$

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .16}$$

Large Schools, 1500 Pupils

$$\text{Average capacity of classrooms} = \frac{\text{average size of class}}{1.00 - .04}$$

$$\text{Average capacity of special rooms} = \frac{\text{average size of class}}{1.00 - .10}$$

APPENDIX

Tables 15 to 30, inclusive, are the tabulations made directly from the teachers' program cards, shown on page 7 above. Each table represents a junior high school and shows for that school the number of pupils reciting the various number of 10, 8, 6, 5, and so forth periods per week, the total pupil-periods in each subject, and the pupil-periods in each subject per 1000 pupils in school.

Tables 31 to 33, inclusive, present the total pupil-periods per subject in the schools included in this study classified according to size.

Tables 34 to 36, inclusive, show Tables 31 to 33 reduced to a common unit, namely 1000 pupils, for purposes of direct comparison.

TABLE 15
SCHOOL NUMBER 1
1800 Pupils

Subject	10	6	Periods Per Week 5	4	3	2	1	Total PP	PP Per 1000
English			2259					11295	6280
Latin			75					375	210
French			162					810	450
Social science			1509	749			782	11323	6300
Mathematics			1816					9080	5100
Science			317					1585	880
Art		48	30	25		1109	347	3103	1720
Music						321	1468	2110	1175
Mechanical drawing	32	85		231		128		2010	1120
Wood shop	87		58	67	25	60	34	1657	930
Metal Shop		27		202		55		1080	600
Printing	83			148		57		1036	575
Foods		67		474				2298	1275
Clothing	239	26				315		3176	1765
Bookkeeping			41					205	115
Typewriting			244					1220	690
Study			534					. 2670	1480
Physical education						1816		3632	2020
Hygiene							1473	1473	815

TABLE 16

SCHOOL NUMBER 2

1585 Pupils

Subject	Periods Per Week						Total PP	PP Per 1000
	6	5	4	3	2	1		
English		382	1203				6722	4250
Foreign language		437					2185	1375
Social science		1585					7945	5000
Mathematics			382	1050			4678	2950
Science				191	1394		3361	2130
Art					111	1340	1562	985
Music						1240	1240	780
Mechanical drawing				134	211	393	1217	765
Shops	345	90		92		202	2998	1895
Foods				301	92	372	1457	920
Clothing				301	92	372	1457	920
Bookkeeping		173					865	545
Commercial subjects		311					1555	980
Auditorium					1585		3170	2000
Physical education		1585					7945	5000

TABLE 17

SCHOOL NUMBER 3

1580 Pupils

Subject	Periods Per Week					Total PP	PP Per 1000
	5	4	3	2	1		
English	1562		252	243		9052	5730
Latin	101					505	320
French	93					465	295
Spanish	338					1690	1070
Social science	1311					6555	4150
Mathematics	1490					7450	4720
Science	310					1550	980
Art	297					1485	930
Music			368	377		1858	1175
Glee club and chorus				65		130	82
Mechanical drawing	145					725	460
Wood shop	103					515	325
Printing	81					405	256
Home mechanics	51					255	162
Electricity	101					505	320
Foods	75					375	238
Clothing	88					440	280
Household arts	86					430	273
Typewriting*	191					955	605
Penmanship		127		160	208	1136	720
Hygiene	25					125	79
Physical education			812	663		3762	2385
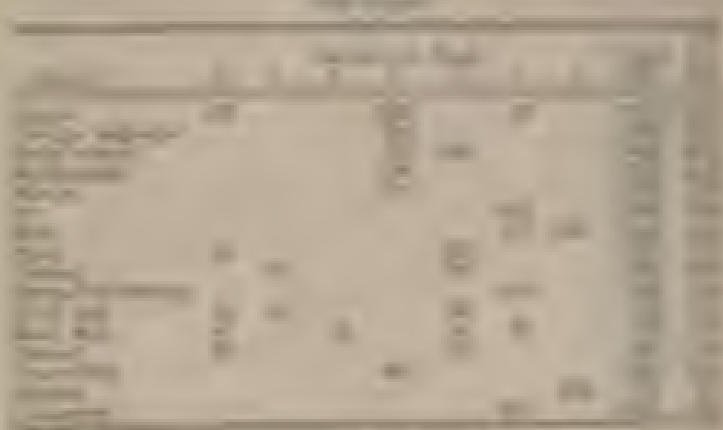
TABLE 22

SCHOOL NUMBER 8

1209 Pupils

| Subject | Periods Per Week | | | | | | Total PP | PP Per 1000 |
	6	5	4	3	2	1		
English		230	979				5066	4190
Foreign languages		128					640	530
Social science		1209					6045	5000
Mathematics			461	711			3977	3290
Science				230	979		2648	2180
Art					40	1096	1176	970
Music						986	986	815
Mechanical drawing				73	150	323	842	695
Shops	223		112	112		99	2221	1750
Foods				157	120	249	960	792
Clothing				157	120	249	960	792
Bookkeeping		137					685	565
Commercial		357					1785	1480
Auditorium					1209		2418	2000
Physical education		1209					6045	5000

TABLE 23

SCHOOL NUMBER 9

1125 Pupils

| Subject | Periods Per Week | | | | | | Total PP | PP Per 1000 |
	6	5	4	3	2	1		
English	854	223					6239	5546
Latin		113					565	502
Social science			348	1264	121		5426	4823
Mathematics		667	327	87			4904	4359
Science				541			1623	1443
Typewriting					186		372	331
Bookkeeping			95				380	338
Commercial				90	78		426	379
Penmanship					95	30	220	196
Mechanical drawing			102		202		812	722
Electric shop			155		72		764	680
Woodwork			91		70		504	448
Cabinet making			91		42		448	398
Machine shop			265		27		1114	990
Sheet metal			128				512	455
Foods			122		48		584	520
Clothing	60		266		78	19	1599	1420
Art					792		1584	1408
Gymnasium					579		1158	1029
Hygiene						579	579	515
Swimming						521	521	464

TABLE 24
SCHOOL NUMBER 10
1104 Pupils

Subject	5	4	3	2	1	Total PP	PP Per 1000
English	1111			76		5707	5169
Latin	41					205	185
French	28		36			248	225
Spanish	222					1110	1006
Social science	920					4600	4167
Mathematics	503	438	11			4300	3895
Science	216					1080	978
Art	113			111	71	858	777
Music				594	223	1411	1279
Chorus					279	279	253
Mechanical drawing	149					745	675
Wood shop	98					490	444
Metal shop	89					445	403
Shoe shop	9					45	41
Printing	101					505	457
Electric shop	98					490	444
Foods	49			21		287	260
Clothing	114					570	516
Household arts	122					610	553
Typewriting	153					765	693
Penmanship	108				451	991	898
Study	269		24	102		1621	1468
Hygiene				215		430	390
Physical education	227		1087	129	74	4728	4283

TABLE 25
SCHOOL NUMBER 11
1044 Pupils

Subject	10	8	6	5	4	3	2	1	Total PP	PP Per 1000
English				1085					5425	5196
Latin				100					500	479
Social science				548					2740	2625
Mathematics				906					4530	4350
Science				303					1515	1450
Art				119		44	161		1049	1005
Music				87	99		62		955	915
Cooking	31	34	35						792	760
Sewing	64		23		18		16		882	845
Mechanical drawing	54								540	517
Wood shop	20		22		27				440	420
Sheet metal	88								880	843
Auto	21		28		10				418	400
Bookkeeping	191								1910	1830
Typewriting				174					870	833
Penmanship				193	30				1085	1040
Shorthand				99					495	475
Business efficiency				14					70	67
Physical training	176						308	51	2426	2324

TABLE 26

SCHOOL NUMBER 12

1028 Pupils

Subject	Periods Per Week					Total PP	PP Per 1000
	10	5	4	2	1		
English		893			44	4509	4386
Foreign languages		141				705	685
Social science		1101				5505	5355
Mathematics		995				4975	4839
Science		145				725	705
Art		153		933		2631	2568
Music				806		1612	1560
Mechanical drawing	38	65				705	685
Wood shop	302		36			3164	3078
Metal shop	74			•		740	720
Printing	64					640	623
Electric shop	58					580	565
Foods	151	132				2170	2111
Clothing	14	49				385	375
Typewriting	28	129				925	900
Penmanship				529		1058	1029
Shorthand		39				195	190
Study		158				790	769

TABLE 27

SCHOOL NUMBER 13

840 Pupils

Subject	Periods Per Week						Total PP	PP Per 1000
	10	8	5	4	3	2		
English			821				4105	4887
Foreign languages			99				495	589
Social science			757				3785	4506
Mathematics			829				4145	4935
Science			133				665	792
Art			35	99		374	1319	1570
Typewriting		52	86				846	1007
Stenography			64				320	380
Penmanship						336	672	800
Mechanical drawing	33						330	392
Wood shop		81					648	772
Metal shop	15						150	180
Electric shop	45						450	535
Printing	48						480	572
Foods	24	43					584	695
Clothing	36	55	46				1030	1226
Study			930		41		4773	5682

TABLE 28

SCHOOL NUMBER 14

818 Pupils

Subject	Periods Per Week						Total PP	PP Per 1000
	6	5	4	3	2	1		
English		137	681				3409	4168
Foreign languages		161					805	984
Social science		818					4090	5000
Mathematics			275	487			2561	3131
Science				137	681		1773	2168
Art					109	672	890	1089
Music						687	687	840
Mechanical drawing				37	94	304	603	737
Shops	131	85		85		120	1586	1940
Foods				161	53	127	716	875
Clothing				161	53	127	716	875
Bookkeeping		91					455	555
Commercial subjects		177					885	1082
Auditorium					818		1636	2000
Physical education		818					4090	5000

TABLE 29

SCHOOL NUMBER 15

815 Pupils

Subject	Periods Per Week					Total PP	PP Per 1000
	5	4	3	2	1		
English	879		30		148	4633	5685
Latin	107					535	657
Social science	1334					6670	8185
Mathematics	863				439	4754	5853
Science	163					815	1000
Art					184	184	225
Music	70				324	674	827
Mechanical drawing			121	8		379	465
Wood shop		22	270	11	16	936	1150
Foods			79			237	290
Clothing			197			591	725
Bookkeeping	22					110	135
Typewriting		16				64	80
Penmanship					232	232	285
Physical education				593		1186	1455

TABLE 30

784 Pupils

Subject	Periods Per Week					Total P.P.	P.P Per 1000
	5	4	3	2	1		
English	992					4960	6327
Latin	233					1165	1486
French	24					120	153
Social science	402					2010	2564
Mathematics	470					2350	2998
Science	403					2015	2570
Bookkeeping	63					315	402
Typewriting	112					560	715
Shorthand	88					440	561
Penmanship					60	60	77
Music				222		444	566

TABLE 31

DISTRIBUTION OF PUPIL PERIODS PER WEEK ACCORDING TO SUBJECTS IN JUNIOR
HIGH SCHOOLS OF OVER 1200 PUPILS ENROLLED

	Ann Arbor						Detroit				Denver		Rochester		Total
							Bachur (?)		Hutchins	Byers	M'cy	Skinner	Madison		
Enrollments	1,580	1,447	1,176	1,571	1,575	1,200	1,295	1,249	1,204	1,290	1,471				15,493
English					6,730	5,036	3,112	7,587	6,905	7,701	7,920				84,950
Latin							2,990	1,600	1,640	880					
French		1,540			2,185	640		675	386	554	(1,700				38,662
Science								1,115	608	880					
Social science					7,945	6,445	6,135	4,987	4,173	4,506	5,720				73,052
Mathematics					4,454	5,775	6,876	6,178	5,784	5,700	6,231				65,984
Science						5,044		925		1,507	2,868				29,149
Art					1,641	1,778	1,071	2,976	2,586	2,169	2,703				21,262
Music					1,944	943	1,444	1,576	1,974	975	1,095				14,218
Mechanical drawing					1,122		711	904	146	243	701				4,785
S...						2,611	1,606	1,587	1,600	2,674					35,721
P...								240			344				...886
P...					1,447	702	848	989	208	1,181	976				10,788
C...					1,167	960	489	1,297	1,196	1,854	1,614				15,485
Household arts								655	491		713				1,980
Bookkeeping					963	645	149				947				3,067
Typewriting			125	655				528			463				5,666
Penmanship	1,390		786	1,156							796				1,622
Commercial					1,565	1,785	590	741	1,391	2,224					4,556
Auditorium					3,171	3,418	2,450								
H...	1,153	945	555	125											3,408
Health	3,622	1,584	1,715	2,702	7,945	6,045	6,125	2,897	2,559	3,426	1,852				40,842
															458,630

DISTRIBUTION OF PUPIL-PERIODS PER WEEK ACCORDING TO SUBJECTS IN JUNIOR
HIGH SCHOOLS OF FROM 750 TO 1199 ENROLLMENT

TABLE 32

Enrollments	Duluth Lincoln	Washington	Sioux City West	Grand Rapids Strong	Cincinnati Bloom	Columbus Pilgrim	San Diego Memorial	Detroit Miller	Denver Gove	Total
	840	1,028	815	1,044	1,125	784	1,104	818	962	8,520
English	4,005	4,500	4,633	5,425	6,239	4,060	5,707	3,409	5,561	44,448
Latin										
French	495	705	565	500	565	1,165	205	805	2,782	9,185
Spanish						120	248			
Social science	3,785	5,505	6,670	2,740	5,426	2,010	5,000	4,090	3,670	38,896
Mathematics	4,145	4,973	4,753	4,580	5,904	2,650	4,300	2,561	4,824	38,392
Science	665	725	815	1,315	1,623	2,015	1,080	1,773	748	10,959
Art	1,319	2,631	184	1,049	1,584		538	890	1,940	10,455
Music		1,612	674	855			1,690	687	1,834	7,796
Mechanical drawing	330	705	379	540	812	444	745	603	69	4,183
Shops										
Wood	648	2,444	936				490			
Metal	150	740		440	952		445			
Printing	480	610		1,298	1,626		505			
Home mechanics							45	1,586	1,497	16,437
Electricity					761		490			
Home economics	450	580								
Food				792	584		287	716	625	5,954
Clothing	584	2,170	237	882	1,590		570	716	478	6,251
Household arts	1,630	385	591	70			610			610
Commercial										
Bookkeeping	846	925	110	1,910	426	315		885		
Typewriting	360	195	64	570	380	500		455	1,621	12,059
Shorthand	672	529	232	495	372	410	765			
Penmanship				1,085	220	60	991			3,781
Auditorium								1,636		1,636
Hygiene					579		430			1,009
Physical education			1,186	2,426	1,680		4,728	4,090	1,852	15,962
										228,013

TABLE 33
DISTRIBUTION OF PUPIL-PERIODS PER WEEK ACCORDING TO SUBJECTS IN JUNIOR HIGH SCHOOLS WITH LESS THAN 750 ENROLLMENT

	Duluth		Irving	Sioux City		Denver	Detroit	
	Morgan Park	Denfield		East	Broadway	Grant	Neinas	Total
Enrollments	157	426	359	655	523	464	724	3,308
English	1,055	3,324	1,840	3,629	3,074	2,774	3,028	18,679
Latin	85	650	85	615	317	152	405	2,860
French		15			146	157		
Spanish					233			
Social science	650	1,415	1,935	5,420	2,125	1,538	3,620	16,703
Mathematics	755	2,290	1,765	3,613	2,556	1,984	2,234	15,197
Science	115	360		468	140	212	1,580	2,875
Art	870	707	1,229	688	960	862	706	6,022
Music	215		597	680	631	928	567	3,618
Mechanical drawing	180	470		297		133	576	1,056
Shops	730	1,810		507	936		1,477	5,460
Printing				87	44			131
Foods	304		590	431	287		882	2,494
Clothing	425		643	576	571		882	3,097
Home economics						227		227
Bookkeeping	100		420	330				3,898
Typewriting				370	311	173	370	
Commercial					495	599	730	
Penmanship				597				597
Auditorium							1,448	1,448
Hygiene	115			63				178
Physical education	474		672	2,105	864	909	3,620	8,644
								93,784

TABLE 34

DISTRIBUTION OF PUPIL-PERIODS PER WEEK IN EACH SUBJECT REDUCED FROM
TABLE 31 TO COMMON UNIT OF 1000 PUPILS
JUNIOR HIGH SCHOOLS WITH 1200 PUPILS AND OVER

	Audubon	Cleveland Kennard	Empire	San Diego Roosevelt	Barbour	Detroit Condon	Hutchins	Byers	Denver Morey	Skinner	Rochester Madison	All Schools
Enrollments	1,800	1,447	1,376	1,580	1,585	1,209	1,225	1,249	1,201	1,290	1,471	15,433
English	6,280	7,050	5,125	6,000	4,250	4,180	4,175	6,295	5,750	5,983	5,420	5,490
Foreign languages	660	1,270	1,705	1,685	1,375	530	2,440	2,270	2,260	1,782	1,160	2,500
Social science	6,300	6,180	6,200	4,150	5,000	5,000	5,000	3,900	3,460	3,260	3,920	4,850
Mathematics	5,100	4,100	5,020	4,720	2,950	3,290	3,250	4,930	4,780	4,480	4,250	4,250
Science	880	750	815	980	2,130	2,180	2,175	740	732	1,240	2,290	1,310
Art	1,720	1,700	600	930	985	970						
Music	1,175	1,480	900	1,175	780	815	935	1,230	855	200	840	965
Mechanical drawing	1,120	430	650	460	765	695	580	478	96	220	520	568
Shops	2,105	2,299	2,930	1,076	1,895	1,750	1,365	1,614	1,600	2,075	3,296	1,910*
Foods	1,275	750	1,060	238	860	792	735	530	169	920	189	695
Clothing	1,765	1,235	1,210	280	860	793	735	965	935	1,045	823	988
Home economics	115			273				285	410		479	129
Bookkeeping	690		90	605	545	565	145	593			645	198
Typewriting		276	576	720				422			315	385
Penmanship											535	124
Commercial									1,155	1,730		535
Auditorium	815	630	650	79	985	1,480	455					520
Hygiene					2,000	2,000	2,000					222
Physical training	2,020	955	1,390	2,385	5,000	5,000	5,000	1,910	1,950	2,650	1,260	2,640
Classrooms	18,340	18,600	18,050	16,555	13,575	13,000	14,865	17,395	16,250	15,505	14,750	17,090
Vocational	7,070	4,990	6,516	3,652	5,910	6,075	4,015	4,887	4,365	5,990	6,802	5,532
Fine arts	2,895	3,180	1,500	2,105	1,765	1,785	1,935	3,055	2,745	1,880	2,680	2,345
Science	880	750	815	980	2,130	2,180	2,175	740	732	1,240	2,290	1,310
Health	2,835	1,585	2,040	2,464	5,000	5,000	5,000	1,910	1,950	2,650	1,260	2,862
Auditorium					2,000	2,000	2,000					520

* Includes Printing Shop.

TABLE 35

DISTRIBUTION OF PUPIL-PERIODS PER WEEK IN EACH SUBJECT REDUCED FROM TABLE 32 TO COMMON UNIT OF 1000 PUPILS JUNIOR HIGH SCHOOLS WITH 750 TO 1200 PUPILS

	Duluth		Sioux City	Grand Rapids	Cincinnati	Columbus	San Diego	Detroit	Denver	All
	Lincoln	Washington	West	Strong	Bloom	Pilgrim	Memorial	Miller	Gove	Schools
Enrollments	840	1,028	815	1,044	1,125	784	1,104	818	962	8,520
English	4,750	4,375	5,690	5,200	5,525	6,350	5,190	4,165	5,775	5,215
Foreign language	580	685	655	480	500	1,740	1,375	985	2,880	1,080
Social science	4,500	5,360	8,170	2,620	4,820	2,565	4,545	5,000	3,815	4,565
Mathematics	4,945	4,825	5,850	4,390	5,250	3,000	3,900	3,130	5,000	4,500
Science	790	705	1,000	1,450	1,445	2,570	980	2,160	775	1,225
Art	1,570	2,550	225	1,005	1,405		780	1,090	2,015	1,225
Music		1,575	825	815		565	1,530	840	1,900	915
Mechanical drawing	395	685	465	515	720		675	735	75	490
Shops	2,055	4,280	1,150	1,660	2,970		1,790	1,940	1,555	1,930
Home economics	1,920	2,480	1,075	1,600	1,940	1,680	1,340	1,750	1,125	1,475
Commercial	1,415	1,090	215	4,525	1,145		695	1,640	1,680	1,415
Penmanship	800	510	285	1,020	195		900			445
Auditorium								1,875		190
Physical education and hygiene			1,460	2,325	2,005		4,675	5,000	1,920	1,875
Classrooms	14,775	15,245	20,365	12,690	16,095	13,655	15,010	13,280	17,470	15,360
Vocational	5,785	8,535	2,905	8,300	6,775	1,680	4,500	6,065	4,435	5,310
Fine arts	1,570	4,125	1,045	1,820	1,405	565	2,310	1,930	3,915	2,140
Science	790	705	1,000	1,450	1,445	2,570	980	2,160	775	1,285
Health			1,460	2,325	2,005		4,675	5,000	1,920	1,875

TABLE 36

DISTRIBUTION OF PUPIL-PERIODS PER WEEK IN EACH SUBJECT REDUCED FROM
TABLE 33 TO COMMON UNIT OF 1000 PUPILS
JUNIOR HIGH SCHOOLS WITH LESS THAN 750 PUPILS

	Morgan Park	Duluth Denfield	Irving	Sioux City East	Broadway	Denver Grant	Detroit Neinas	All Schools
Enrollments	157	426	359	655	523	464	724	3,308
English	6,400	7,800	5,110	5,525	5,880	5,980	4,180	5,645
Foreign language	540	1,560	235	935	1,330	665	560	865
Social science	4,145	3,310	5,380	8,250	4,060	3,310	5,000	4,860
Mathematics	4,800	5,375	4,910	5,500	4,900	4,275	3,075	4,595
Science	735	845		715	270	455	2,180	870
Art	5,530	1,650	3,420	1,045	1,835	1,860	975	1,820
Music	1,370		1,660	1,035	1,220	2,000	780	1,095
Mechanical drawing	1,150			455		285	995	500
Shops	4,650	1,100		905	1,875		2,035	1,690
Home economics	4,650	4,250	3,430	1,540	1,640	490	2,440	1,760
Commercial	635		1,170	1,070	1,540	1,665	1,520	1,180
Penmanship				905				180
Auditorium							2,000	440
Health	3,750		1,870	3,200	1,650	1,960	5,000	2,670
Classrooms	15,885	18,045	15,635	20,210	16,170	14,230	12,815	15,965
Vocational	11,085	5,350	4,600	3,970	5,055	2,440	6,990	5,130
Fine arts	6,900	1,650	5,080	2,080	3,055	3,860	1,755	2,915
Science	735	845		715	270	455	2,180	870
Health	3,750		1,870	3,200	1,650	1,960	5,000	2,670